2016 at the Collinear Resonance Ionisation Spectroscopy (CRIS) experiment

Results of experiment IS531 and IS594

Website: http://isolde-cris.web.cern.ch/isolde-cris/

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In 2016, two successful experiments were performed with the CRIS experiment. In April, the hyperfine structures of the ground states of $^{63\text{-}66,68\text{-}78}$Cu were measured together with 2 isomeric states in both ^{68}Cu and ^{70}Cu. High resolution coupled to high efficiency led us to resolve the hyperfine structures of ^{78}Cu with about 20 ions/s production yield and a resonance linewidth of 70 MHz. (Fig. 1) [1]. In August the neutron-rich Ra isotopes were studied. The hyperfine structures of $^{226\text{-}232}$Ra were obtained with high resolution together with low resolution measurements on ^{233}Ra. The analysis of both experiments will allow for the extraction of ground state spins, magnetic dipole moments, electric quadrupole moments and changes in mean-squared charge radii.

Improvements to the beam line and laser systems over the past year have made these measurements possible, as detailed in recent technical publications [2, 3]. A combined decay and laser spectroscopy paper of the isotope ^{214}Fr was also published [4] this year, along with a technical article on the upgraded Decay Spectroscopy Station [5].

Recently two pulsed Ti:Sa lasers have been installed to replace the cavities on loan from the Johannes Gutenberg University Mainz. Furthermore, first steps towards better long-term frequency stabilization and improved measurement accuracy were made. The newly installed DLC pro 780 diode laser together with the saturation spectroscopy module and the locking electronics will allow us to improve the accuracy of wavelength measurements, which was previously limited to 3 MHz. By locking the diode laser to one of the hyperfine transitions in Rb or K, a stable frequency reference can be obtained, which can be used for regular and reliable wavemeter calibrations. The system is completed with a Fabry–Pérot interferometer which enables us to compare the wavelength of the scanning laser to the stable frequency reference. The goal is to reach a long term frequency stability of less 1 MHz, which will allow us to study lighter atomic systems.

Even more recently a three-axis adjustable charge exchange cell and new vacuum chamber have been installed (Fig. 2) which should increase neutralization efficiency by allowing different alkali metals to be used, at higher temperatures. In addition, a new differential pumping iris was installed, which will reduce collisional background events caused by isobaric contaminants and further enhance the sensitivity of CRIS.

In preparation for planned experiments on In, K and Sn this year a new versatile ion source setup was installed over the summer which allows for surface ionization, plasma ionization and laser ionization of a gas stream or solid target. A new high-voltage cage arrangement around the ion source will allow extraction voltages of up to 30 kV to replicate typical beam energies from ISOLDE. This will enable us to accurately test laser ionization schemes and neutralization efficiency of a wide variety of elements offline.

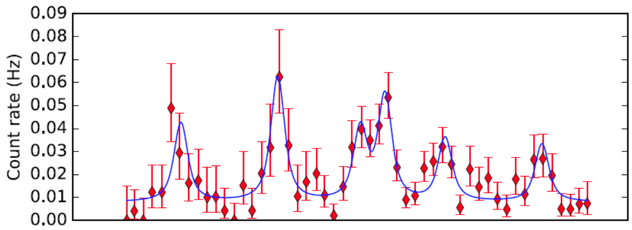

Fig. 1: Hyperfine spectra of ^{78}Cu obtained during IS531. Horizontal axis is frequency (MHz) with a range of 2 GHz.

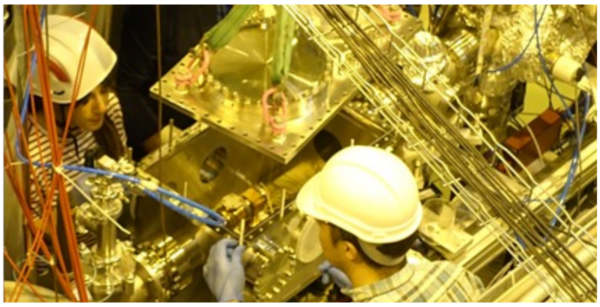

Fig. 2: The new charge-exchange cell and vacuum chamber in place at CRIS being wire sealed.

[1] R. P. de Groote in preparation

[2] T.E. Cocolios, et al. NIM. B 376, 284 (2016).

[3] R. P. de Groote, K. M. Lynch & S. G. Wilkins, HI 238, 5 (2017).

[4] G. J. Farooq-Smith, et al. PRC 94, 054305 (2016).

[4] K. M. Lynch, et al., NIM. A 844, 14–18 (2017).